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THE TRITIUM SYSTEMS TEST ASSEMBLY: OBJECTIVES AND DESIGN*

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The Tritium Systems Test Assembly (TSTA) is dedicated to the development, demonstration, and interfacing of technologies related to the deuterium-tritium (DT) fuel cycle for fusion reactor systems. The first such reactor system to be built might be the Engineering Test Facility (ETF) or the International Tokamak Reactor (INTOR). The ETF would be followed by an Engineering Prototype Reactor (EPR) and later a Demonstration Reactor (DEMO), which would produce net electricity to be supplied to the commercial power grid. These later reactors will build and expand on the tritium handling system designed for ETF or INTOR. The Los Alamos Scientific Laboratory (LASL) plans to design, fabricate, construct, test and bring the Tritium Systems Test Assembly into operation by the end of 1981. LASL will then operate TSTA for several years thus gaining data on the efficiency, adequacy, reliability and availability of the components and subsystems at TSTA before the final design of an ETF or INTOR tritium handling facility is chosen.

The principal program objectives for TSTA are:

- To develop and demonstrate the fuel cycle for fusion power reactors;
- To develop and test environmental and personnel protective systems;
- To develop, test, and qualify equipment for tritium service;
- To provide a final demonstration facility that could be directly copied for a D-T burning fusion machine;
- To demonstrate long-term reliability of components;
- To demonstrate long-term safe handling of tritium with no major releases or incidents; and
- To investigate and evaluate the response of the fuel cycle and environmental packages to normal, off-normal, and emergency situations.

The TSTA will consist of a large gas loop, Fig. 1, which can simulate the proposed fuel cycle for a fusion facility. The loop, as shown, does not include any specific fuel injection system, but will be sufficiently versatile so that such systems can be added as the design requirements are better defined. The gas loop will be designed to handle up to 360 gram moles per day DT. This flow will provide cycle operating experience on a scale that is equal to or greater than the full-scale fuel cycles currently being addressed for ETF and INTOR systems.

To accomplish this at TSTA will require an onsite tritium inventory of approximately 200 g.

The assembly to meet these objectives will comprise the following integrated subsystems:

- A vacuum facility based on a compound cryocondensation/cryosorption pump for exhausting gas from the reactor.
- A fuel cleanup system for removing all chemical impurities from the hydrogen isotope stream recovered from the vacuum facility. This system will consist of catalytic oxidizers, adsorber beds and hot metal beds to achieve the necessary chemical purification.

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- A hydrogen isotope separation system which will be a cryogenic fractional distillation system to produce pure D_2, pure T_2, a DT mixture and to remove H_2 (normal hydrogen) as a waste product.
- A number of organic-free, all metal, sealed circulation pumps for moving the gas stream through the main process loop.
- A number of interfaces with external systems (neutral beam, coolant loop and breeding blanket system).
- A fuel mixing/injection system for introducing the appropriate quantities of DT into the reactor. The TSTA will also include a system for injecting appropriate impurities into the torus fuel prior to exhausting it through the vacuum facility. This DT gas might contain as much as 1% total of such impurities as H_2O, CH_4, NH_3, He and CO_2. These must be reduced to a total impurity level <5 parts-per-million by the fuel cleanup system.
- A tritium waste treatment system to remove tritium from routinely generated gaseous effluents before release to the environment.
- An emergency tritium cleanup system capable of processing all of the air in the facility to recover tritium in event of a major release of gaseous tritium to the facility.
- A number of associated functions, including waste disposal, tritium monitoring, system maintenance, computer control and gas analysis.

The design and function of each of these subsystems is discussed in detail.

Because the development of TSTA now will permit operation and evaluation of the required fuel cycle well in advance of the final design of ETF or INTOR, development of the tritium system need not be a pacing item in the design of ETF or INTOR.

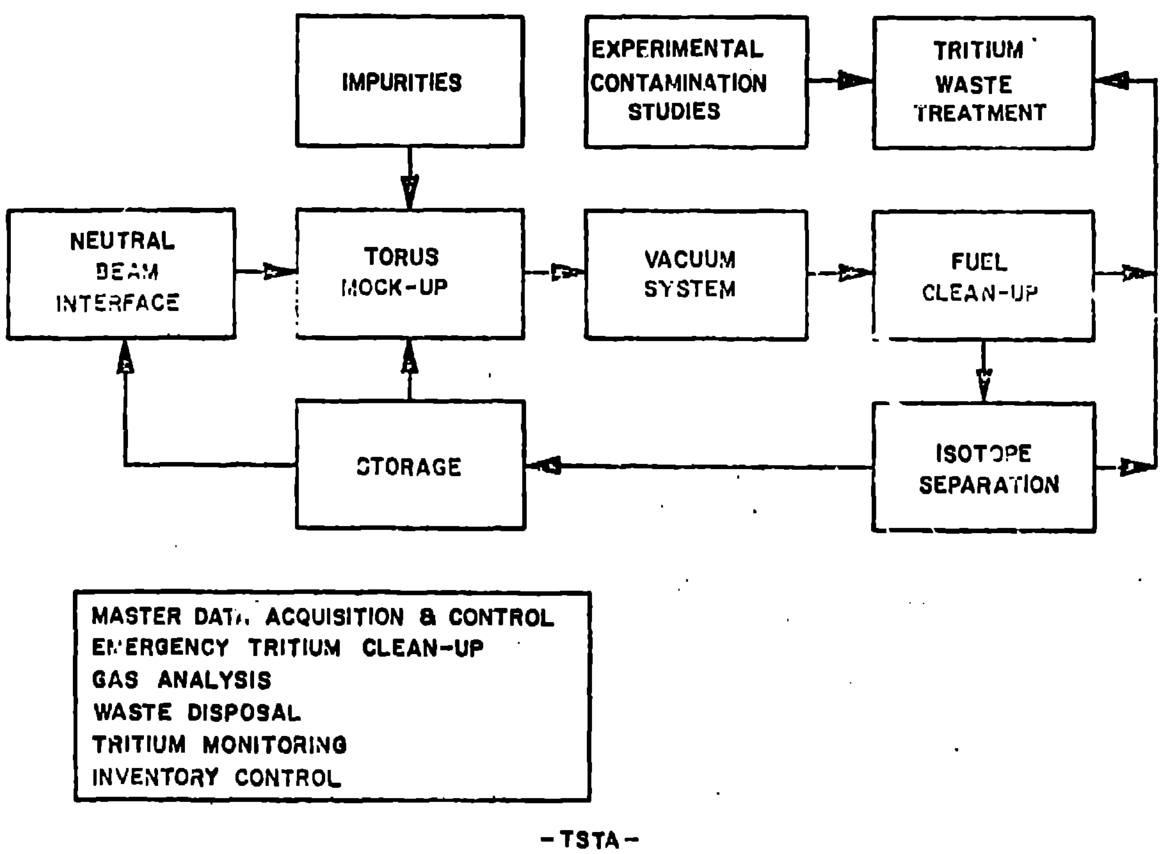

Fig. 1. MAIN PROCESS LOOP AND AUXILIARY SYSTEMS